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EP 0449185 A

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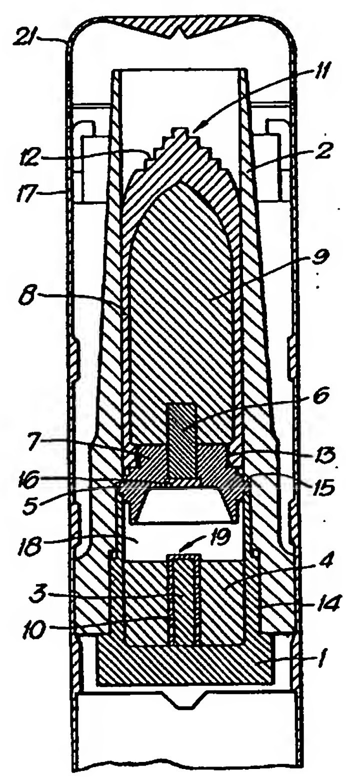
Online:WPI

(54) Abstract Title
Torpedo warhead

(57) A lightweight torpedo warhead for the defeat of multi-hulled vessels, comprising a gun barrel 2 from which is launched, by propellant means 4, a projectile 11 containing a high explosive payload 9 and a delay fuze 6. When the warhead is initiated the projectile is accelerated along and fired from the gun barrel by expanding propellant gasses. The projectile penetrates the outer-hull of the target vessel and the delay fuze detonates the high explosive payload when the projectile is adjacent to the inner-hull.

In a preferred embodiment, the all burnt condition of the propellant occurs after the projectile has exited the gun barrel. In this way the confining effect of water on the expanding propellant gasses is used to continue to accelerate the projectile after it has exited the gun barrel which enables a shorter and thus lighter gun barrel to be used.

Fig.1.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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Fig.1.

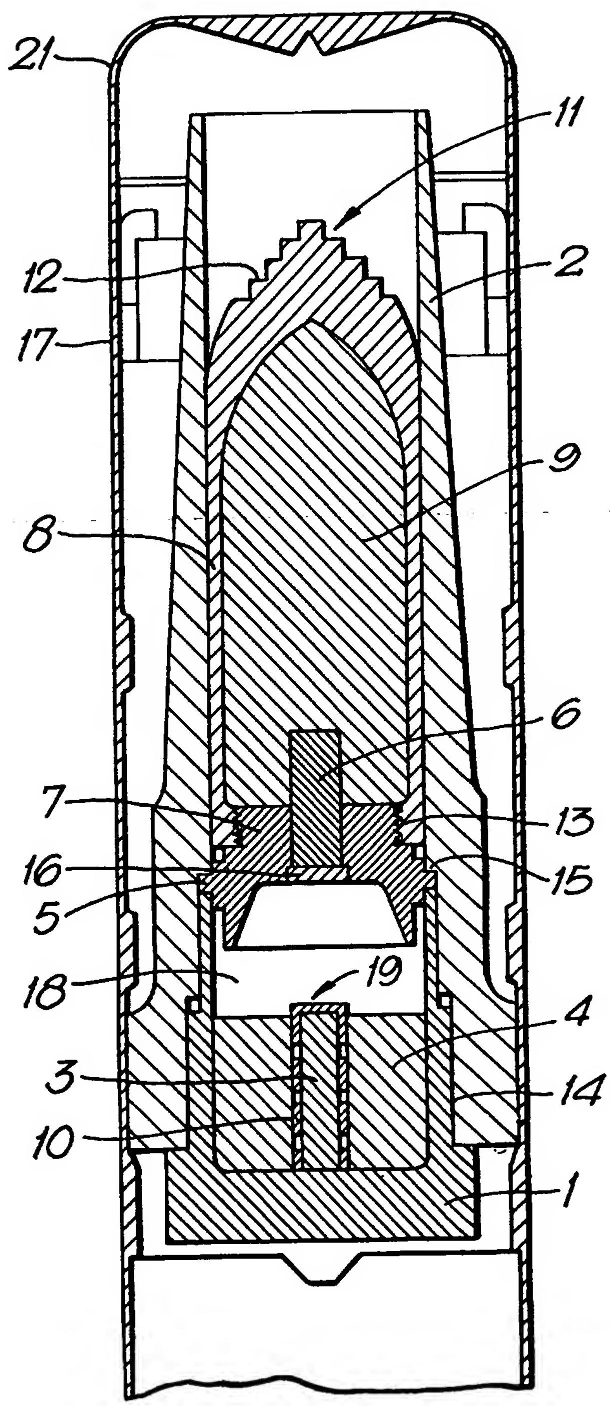


Fig. 4.

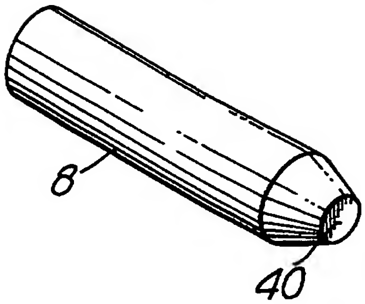


Fig. 2A.

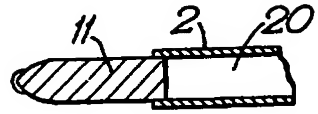


Fig. 2B.

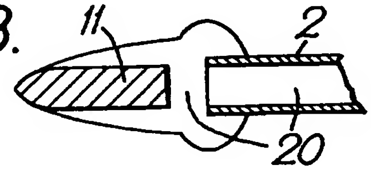


Fig. 2C.

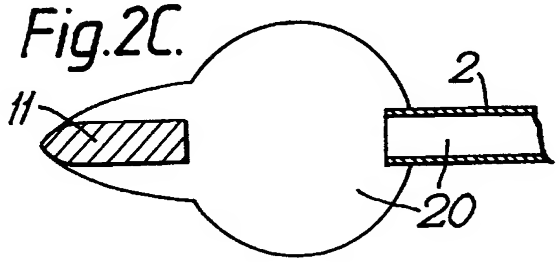


Fig. 2D.

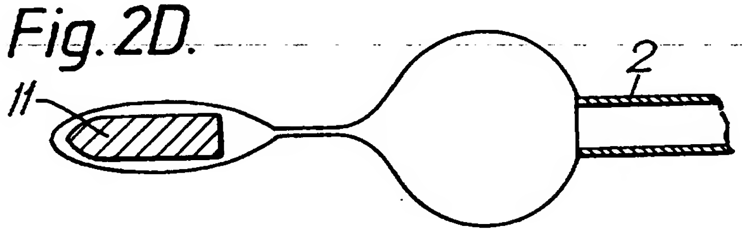
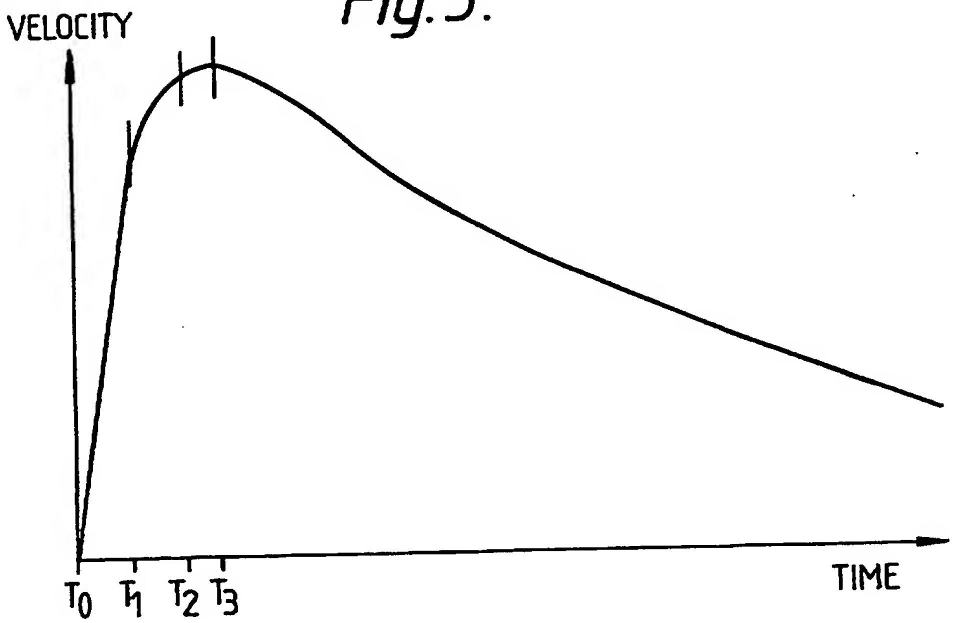


Fig. 3.



TORPEDO WARHEAD

This invention relates to a torpedo warhead and in particular to a lightweight torpedo warhead which is capable of defeating a multi-hulled vessel in particular a submarine having an inner and an outer hull.

In order to disable a submarine having a double-hulled structure, both of the hulls and any interhull structures must be breached. The breach in the inner hull must be above a certain critical size for the damage to the submarine to be fatal. If the breach in the inner hull is below the critical size then the flood of water through the breach can be contained from within and the submarine remains operational.

Certain types of submarines are known to possess inner and outer hulls in order to improve their resistance to attack, since the space between the two hulls is usually filled with water and may additionally contain complex interhull structures which are difficult to penetrate. A common method known in the prior art of defeating a double-hulled submarine using a torpedo is to detonate within the torpedo warhead a single conically-recessed shaped charge, having a high density liner, directed towards the submarine. The shaped charge jet thereby formed can penetrate the double-hulled structure and disable the submarine. The main disadvantage with this method is that the breach in the innermost hull can be smaller than the critical size mentioned above. This disadvantage is exacerbated if the space between the inner and outer hulls contains complex interhull structures which add to the target material to be penetrated by the shaped charge jet. It is difficult to overcome this problem because the shaped charge is constrained in diameter and explosive mass (and thus penetrating power) if it is to be used as a warhead for a torpedo, in particular a lightweight torpedo. A further disadvantage of using a shaped charge warhead is that if the inner hull of the submarine is much smaller than the outer hull, the

shaped charge jet may miss the inner hull altogether, especially for large angles of attack.

The present invention seeks to overcome at least some of the aforementioned disadvantages by providing a torpedo warhead that can successfully defeat a multi-hulled vessel.

According to the present invention there is provided a torpedo warhead comprising a gun barrel open at its forward end and having a propellant charge located at its rearward end, and a projectile which is slideably located forward of the propellant charge within the gun barrel, the said projectile containing a high explosive payload and a delay fuze.

The projectile is accelerated towards the target submarine by expanding propellant gases produced as the propellant charge is consumed. When it achieves its maximum velocity the projectile can breach the outer hull of a submarine and at least partly breach any interhull structures which may be present. The explosive payload of the projectile is detonated by the delay fuze at a predetermined time. The predetermined time is chosen so that the projectile will be adjacent to the inner hull of the submarine when the explosive payload is detonated. The water which is usually present in the interhull space has a confining effect on the blast produced when the explosive payload detonates directing the blast towards the inner hull, thus enhancing the effect of the blast. The hole in the inner hull thus produced can be several orders of magnitude greater than the hole produced by known torpedo warheads of a similar size and mass. Furthermore even if the projectile does not entirely breach the complex interhull structures which may be present before detonation, the blast produced can rip a hole in the inner hull above the critical size.

Preferably the size of the propellant charge used in the torpedo warhead is chosen so that the all burnt condition of the propellant

charge occurs after the projectile has exited the gun barrel. In this preferred form of the present invention the projectile is propelled along the gun barrel by expanding propellant gases which are confined within the gun barrel, as in conventional gun systems, but unconventionally when it exits the gun barrel the projectile continues to be accelerated on the boundary of the expanding propellant gases because they are confined by the surrounding water. The expanding propellant gases continue to accelerate the projectile until the propellant gas pressure is equal to the surrounding water pressure. At this point the projectile achieves it maximum velocity. In this preferred form of the present invention a short gun barrel can be used to accelerate a projectile to the same velocity as a longer gun barrel without the associated massive increase in the size of the propellant charge. Conventionally a short gun barrel requires a greater amount of propellant because the length through which the projectile can be accelerated (ie the length of the gun barrel) is reduced. However, in the present invention because the propellant continues to burn after the projectile has exited the gun barrel and so accelerate the projectile outside of the gun barrel (effectively increasing the length of the gun barrel) only a small increase in the amount of propellant is necessary. Therefore, the torpedo warhead according to this preferred aspect of the present invention can be light and compact while maintaining the required level of target penetration and damage, and therefore can be incorporated into a lightweight torpedo that can successfully disable a submarine.

Preferably the projectile has a truncated ogival nose with a stepped profile. The radius of curvature of the ogive is most preferably between 1.25 and 1.75 times the diameter of the projectile. The diameter of the projectile is the diameter of the cylindrical main body of the projectile. The main advantage of using a projectile of this type is that the stepped nose profile breaks up the water producing a semi-cavitating flow around the projectile which reduces drag and lift. A reduction in drag means

that the deceleration of the projectile by water resistance is reduced and a reduction in lift means that the projectile will deviate less from its trajectory. A warhead of this type has good target penetration characteristics with the added advantage that it is less likely to ricochet from the target at large attack angles.

Alternatively, the projectile preferably has a frusto conical nose. The advantages of using a projectile of this type are the same as those detailed in the previous paragraph (it being the frusto conical nose profile that breaks up the water).

Preferably the projectile has a casing made of a material with a high compressive strength and more preferably the projectile casing is made from high tensile titanium. High tensile titanium has a high compressive strength and so a projectile with such a casing can pierce several layers of the target without substantial deformation. Titanium also has an added advantage in that it is light in mass.

The explosive payload of the projectile is detonated by a delay fuze which is preferably initiated by launch conditions. Using such a delay fuze is a reliable way of detonating the explosive payload when it is near to the inner hull of a submarine for a variety of attack angles and points of attack. As stated above a target submarine may have a complex interhull structure and so the structure that the projectile encounters may vary considerably depending on the attack angle and point of attack. The time it takes for the projectile to near the inner hull is nevertheless found to be a fairly constant parameter on which to base the fuzing system. More preferably the delay fuze is electrical.

Preferably there is a rupturable connecting means between the projectile and the gun barrel. More preferably the rupturable connecting means is in the form of a protrusion of the projectile which engages a step in the internal surface of the gun barrel, the

said protrusion being arranged to shear off the projectile when subjected to a predetermined shear force. Therefore, in operation the projectile is secured within the gun barrel while the propellant gases generated behind the projectile build up to a predetermined pressure, at which point the protrusion shears off the projectile and the projectile is accelerated along the gun barrel. Such a rupturable connecting means is preferable because it optimises the thrust transmitted to the projectile from the propellant gases.

Preferably the warhead is initiated by target sensor means at a predetermined standoff distance from the target. This is advantageous especially if a delay fuze is used that is initiated by launch conditions because such a delay fuze would be based on the estimated time of flight of the projectile before it approaches the inner hull of the submarine target. Obviously varying the standoff distance will vary the time of flight and thus vary the position of the projectile when it is detonated. The predetermined standoff is chosen to ensure that the projectile achieves its maximum velocity just before it impinges on the target. If this is the case then the projectile will have its maximum kinetic energy when it impinges on the outer hull of the submarine so that the penetrating capabilities of the projectile are maximised. In practice the preferred standoff distance would typically be 1 to 2 metres.

Preferably the gun barrel is at least long enough to completely house the projectile. This is advantageous because the gun barrel provides a support for the projectile and directs the projectile along its axis so that the projectile is launched along a stable trajectory. Also, since the projectile contains an explosive payload, it is safer if the projectile is not exposed. In the present invention a longer gun barrel is slightly more propellant efficient than a shorter gun barrel. However, a shorter gun barrel is substantially lighter and more compact while still being relatively fuel efficient. The length chosen for the gun barrel depends mainly on the amount of space available in the torpedo on

which the warhead is to be mounted. For this reason it is preferable that the gun barrel has a length of less than 900mm if it is to be mounted within the front end of a lightweight torpedo.

Preferably the torpedo warhead is mounted within the fore body of a torpedo and is enclosed therein by a torpedo hull which has a frangible nose section. The warhead is enclosed as this makes the torpedo much safer to handle and protects the warhead from sea water. The nose cone of the torpedo hull is preferably frangible so that the projectile can break through the casing without dissipating a large amount of kinetic energy.

Preferably the torpedo warhead is mounted on the fore body of a lightweight torpedo so that the torpedo carrying the warhead can be launched from an airborne carrier for example a helicopter that is difficult for the submarine to detect and accelerate away from.

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section taken through a torpedo warhead according to the present invention containing a semi-armour piercing projectile located within a gun barrel.

Figures 2A to 2D show a projectile similar to the projectile illustrated in Figure 1 at sequential stages as it is accelerated both inside and outside of the gun barrel.

Figure 3 is a graph of the projectile velocity plotted against time.

Figure 4 is a perspective view of an alternative projectile for use in the warhead illustrated in Figure 1.

One embodiment of the gun system according to the present invention will now be described with reference to Figure 1.

Referring first to a breech assembly 1 of the warhead, which is made of high strength and low mass metal, preferably titanium alloy, and houses a main solid propellant charge 4. A primer tube 19 is also housed within the breech assembly 1 and is located at the centre of the main propellant charge 4. The primer tube 19 has a cylindrical metal casing 10 with holes pierced therethrough at regular intervals. The cylindrical metal casing 10 contains a primer composition 3.

A projectile, shown generally at 11, is shown loaded into the warhead in Figure 1. The projectile 11 has a projectile casing 8 which is made of high strength and low mass metal, preferably titanium alloy which has been heat treated to a tensile strength of 1.12×10^9 Pascals. The casing 8 has a truncated ogival nose, the radius of curvature of the ogive being 1.5 times the diameter of the projectile, and a stepped nose profile 12. Alternatively the casing 8 could have frusto conical head (shown at 40 in Figure 4). The projectile casing 8 is threadedly secured to a rear cap 7 at interface 13.

The rear cap 7 is made of aluminium alloy and has an axial cylindrical hole bored in it for the location of a timed fuze 6. The timed fuze 6 extends into the cavity formed within the projectile casing 8 and the rear cap 7. This cavity is filled with a high explosive charge 9. The rear cap 7 has an annular protrusion 5 which has an external diameter equal to the external diameter of the front end of the breach assembly 1. The gun barrel 2 is smooth bored and has an internal diameter at its front end which is equal to the largest external diameter of the projectile casing 8, so that the projectile fits slideably within the gun barrel 2. The gun barrel 2 has a step 15 on its internal surface which corresponds to the annular protrusion 5 of the rear cap 7. The gun barrel 2 is

preferably made using lightweight gun technology from high performance fibres wrapped around a metallic liner, for example, from a titanium or a flow formed maraging steel tube overwound with a high strength fibre composite material. This produces a very lightweight, high strength component more suited to a lightweight torpedo.

The projectile 11 is fitted slideably into the breach assembly 1 until the annular protrusion 5 of the rear cap 7 engages with the forward end of the breach assembly 1. The projectile 11 is then secured in place by threadedly securing the gun barrel 2 over the breach assembly 1 at interface 14. The step 15 on the internal surface of the gun barrel 2 fits over the annular protrusion 5 of the rear cap 7 and holds the rear cap 7 and thus the projectile 11 firmly in place. A cavity 18 is left between the rear of the rear cap 7 and the main propellant charge 4.

The timed fuze 6 is an electrically timed device in which the timing is initiated by the firing conditions when the projectile is launched. Alternatively other conventional timed fuzes can be used. The time fuze 6 has an insulating plug 16 located at its rearward end to protect it from the main propellant charge 4.

In Figure 1 the gun system is mounted within the fore body of a lightweight torpedo 17 and is enclosed within the torpedo hull 21. The nose section of the torpedo hull 21 is preferably made of a frangible material. The nose section is further weakened by machining a plurality of petal shaped grooves on the internal surface of the nose of the torpedo hull 21 with the points of the petal shaped grooves meeting at the apex of the nose section. The torpedo 17 can be launched from an airborne carrier (not shown) for example a helicopter and directed towards the target. The torpedo 17 includes a target sensor (not shown) which guides the torpedo onto a target and initiates the warhead at a short standoff from the target to ensure that the projectile reaches its maximum velocity before striking the target.

The warhead herein described operates as follows. The primer tube 19 is initiated by the target sensor within the torpedo 17 when the warhead is typically 1 to 2 metres from the target. The primer charge 3 is therefore ignited and jets of flaming propellant shoot through the holes in the metal casing 10 to initiate the main charge 4. The initiated propellant of the main charge 4 produces hot propellant gases. The pressure of the propellant gases within the cavity 18 builds up and when the pressure reaches a pre-determined value the annular protrusion 5 shears off the rear cap 7 at time T_0 (see Figure 3). The projectile 11 is accelerated by the expanding propellant gases confined within the gun barrel 2 behind the projectile 11. The projectile easily breaks through the nose section of the torpedo hull 21 without dissipating a large amount of kinetic energy. The initial thrust experienced by the projectile when the annular protrusion 5 shears off can be used to initiate the timed fuze 6.

Referring now to Figures 2A to 2D and Figure 3. Figure 2A shows the projectile 11 at time T_1 (see Figure 3) as it is just about to leave the gun barrel 2 of the warhead. The expanding gaseous propellant products 20 confined within the gun barrel 2 continue to expand and thus accelerate the projectile 11.

Figure 2B shows the projectile 11 at time T_2 (see Figure 3) as it has just left the gun barrel 2 of the warhead. The expanding gaseous propellant products 20 are confined by the surrounding water and continue to expand and thus further accelerate the projectile 11. The expanding gaseous propellant products 20 will continue to accelerate the projectile 11 while the propellant gas pressure is greater than the surrounding water pressure.

Figure 2C shows the projectile 11 at time T_3 (see Figure 3) when the propellant gas pressure equals the surrounding water pressure so that the projectile 11 ceases to be accelerated.

Therefore at time T_3 the projectile 11 reaches its maximum velocity, typically of the order of a few hundreds of metres per second.

Figure 2D shows the projectile 11 at a later time T_4 and shows the projectile 11 in a cavitating flow regime. A cavitating flow regime is advantageous because it reduces the drag and the lift experienced by the projectile 11. A cavitating flow regime is encouraged by a projectile 11 that has either a stepped nose profile or a frusto-conical nose profile (shown at 40 in Figure 4). This is because the sharp corners of these nose profiles break up the water.

Figure 3 is a graph of projectile velocity plotted against time. The velocity of the projectile 11 increases rapidly as it is accelerated within the gun barrel 2 from time T_0 to time T_1. The projectile velocity continues to increase from time T_1 to time T_3 as the projectile 11 is accelerated by the expanding propellant gases confined within the surrounding water. The projectile 11 reaches its maximum velocity at time T_3 when the propellant gas pressure becomes equal to the surrounding water pressure. From time T_3 onwards the velocity of the projectile gradually decreases as it is decelerated because of water resistance.

The projectile 11 when launched from the warhead herein described at a maximum velocity typically of a few hundred metres per second will have sufficient kinetic energy to breach several layers of a target structure before coming to a halt. The timed fuze 6 can be set so that the explosive payload 9 detonates as the projectile approaches a selected part of the target. For example where the target is a submarine the projectile 11 is capable of breaching the outer hull and interhull structure of a submarine at a large range of attack angles. The timed fuze is set so that the explosive payload 9 detonates as the projectile nears or contacts the inner hull. The time delay of the fuze is the estimated time of flight of the projectile before the projectile reaches the inner hull of the submarine. The detonation of the explosive payload 9 can rip a hole in the inner hull much larger than the critical size.

CLAIMS

1. A torpedo warhead comprising, a gun barrel open at its forward end and having a propellant charge located at its rearward end, and a projectile which is slideably located forward of the propellant charge within the gun barrel, the said projectile containing a high explosive payload and a delay fuze.

2. A torpedo warhead according to claim 1 wherein the all burnt condition of the propellant charge occurs after the projectile has exited the gun barrel.

3. A torpedo warhead according to any of claim 1 or claim 2 wherein the projectile has a truncated ogival nose with a stepped profile, the radius of curvature of the ogive being between 1.25 and 1.75 times the diameter of the projectile.

4. A torpedo warhead according to any of claim 1 or claim 2 wherein the projectile has a frusto-conical nose profile.

5. A torpedo warhead according to any of the previous claims wherein the projectile has a casing made of a material with a high compressive strength.

6. A torpedo warhead according to claim 5 wherein the casing is made of high tensile titanium.

7. A torpedo warhead according to any of the previous claims wherein the delay fuze is initiated by launch conditions.

8. A torpedo warhead according to claim 7 wherein the delay fuze is electrical.

9. A torpedo warhead according to any of the previous claims wherein there is provided a rupturable connecting means between the projectile and the gun barrel.

10. A torpedo warhead according to claim 9 wherein the rupturable connecting means is a protrusion of the projectile which engages a step in the internal surface of the gun barrel the said protrusion being arranged to shear off the projectile when subjected to a predetermined shear force.

11. A torpedo warhead according to any of the previous claims wherein the warhead is initiated by target sensor means at a predetermined distance from a target.

12. A torpedo warhead according to claim 11 wherein the said predetermined distance is between 1 and 2 metres.

13. A torpedo warhead according to any of the previous claims wherein the gun barrel is at least long enough to house the projectile completely.

14. A torpedo warhead according to any of the previous claims wherein the gun barrel has a length of less than 900mm.

15. A torpedo warhead according to any of the previous claims wherein the warhead is mounted within the fore body of a torpedo and is completely enclosed therein by the torpedo hull which has a frangible nose section.

16. A torpedo warhead according to claim 15 wherein the torpedo is a lightweight torpedo.

17. A torpedo warhead as hereinbefore described with reference to Figures 1 to 4.

13

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number 9214686.9

Relevant Technical fields

(i) UK Cl (Edition K) F3A; B7A

(ii) Int Cl (Edition 5) F42B

Search Examiner
R C SQUIRE

Databases (see over)

(i) UK Patent Office

(ii) Online database: WPI

Date of Search
30 NOVEMBER 1992

Documents considered relevant following a search in respect of claims 1 to 17

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
P,X	EP 0449185 A1 HUGHES	1

SF2(p)